Human Anatomical Modeling

Simulation approach addresses health care concerns

Lawrence Livermore National Laboratory is using the latest versions of NIKE3D and DYNA3D to model and analyze human anatomy for various applications in the health care field. For this work, we use both high-end workstations as well as the Lab's computer facility which has a YMP Cray and a new multi-parallel processor machine with 256 processors.

Capabilities — finite-element analysis is the key

We can model specific geometry very accurately starting with a surface definition of the object to create an identical representation of the object in the form of a three-dimensional solid. Bones are currently modeled as homogeneous isotropic materials. Muscles and tendons are modeled as anisotropic hyperelastic materials for which we can specify an initial tension. We can model physical test geometry, apply appropriate boundary conditions, initial loads and simulate the test using either NIKE3D or DYNA3D. We are able to create animated representation of the model response during the computed simulation.

APPLICATIONS

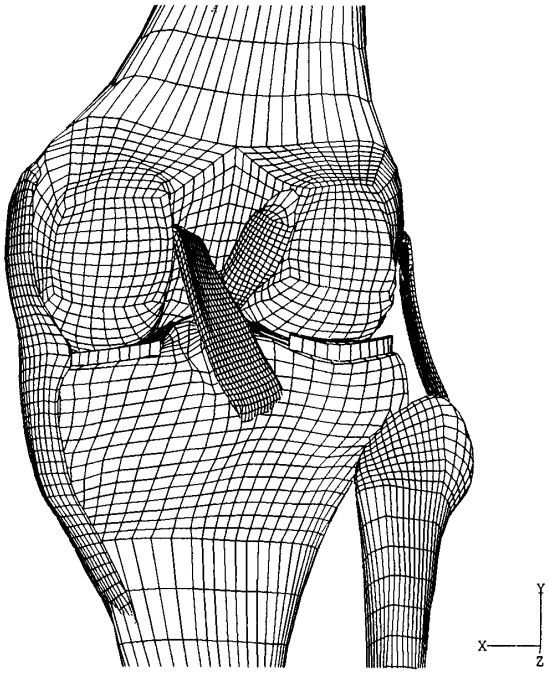
- *Lower extremity including ligaments and muscle mass*
- *Evaluation of prosthetic implants*
- *Material models for behavior of human tissue, ligaments, and muscle*
- *Simulation of physical testing*

Potential applications

Our technique can be used to simulate and evaluate surgical procedures. We can simulate the crash dynamics of an automobile to investigate injury mechanisms for the lower extremities, head, and chest. We can model prosthetic devices, simulate the loading, evaluate them, and suggest changes to improve performance.

Current research and interest

We are currently working on a detailed lower extremity model that includes ligaments, musculotendons, and muscle mass. This model will be used to evaluate injury from severe floor intrusion and body contact with interior features during a simulated auto crash. We are also interested in developing a bone density remodeling capability that would be dependent on loading and time. This could be used to determine the long-term effect of new load bearing paths on the surrounding upper leg bone density after the insertion of a prosthetic hip design. A surgeon could also evaluate various corrective bone surgery options on deformed members and determine the long-term effect on bone density before the operation.



Lower extremity finite-element model of knee region showing modeling of bone, ligaments, and tendons.

Availability: This modeling technology is available now. We are looking for collaborators with whom to further develop and apply this analytical technique in the health care field.

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